



## **KOOTENAI RIVER FISHERIES INVESTIGATIONS: RAINBOW AND BULL TROUT RECRUITMENT**

**ANNUAL PROGRESS REPORT  
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## **Annual Progress Report**

**1999 Annual Report**

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## ABSTRACT

Our 1999 objectives were to determine sources of rainbow trout *Oncorhynchus mykiss* and bull trout *Salvelinus confluentus* spawning and recruitment in the Idaho reach of the Kootenai River. We used a rotary-screw trap to capture juvenile trout to determine age at out-migration and to estimate total out-migration from the Boundary Creek drainage to the Kootenai River. The out-migrant estimate for March through August 1999 was 1,574 (95% C. I. = 825-3,283) juvenile rainbow trout. Most juveniles out-migrated at age-2 and age-3. No out-migrating bull trout were caught. Five of 17 rainbow trout radio-tagged in Idaho migrated upstream into Montana waters during the spawning season. Five bull trout originally radio-tagged in O'Brien Creek, Montana in early October moved downstream into Idaho and British Columbia by mid-October. Annual angler exploitation for the rainbow trout population upstream of Bonners Ferry, Idaho was estimated to be 58%. Multi-pass depletion estimates for index reaches of Caboose, Curley, and Debt creeks showed 0.20, 0.01, and 0.13 rainbow trout juveniles/m<sup>2</sup>, respectively. We estimated rainbow trout (180-415 mm TL) standing stock of 1.6 kg/ha for the Hemlock Bar reach (29.4 ha) of the Kootenai River, similar to the 1998 estimate. Recruitment of juvenile rainbow and bull trout from Idaho tributaries is not sufficient to be the sole source of subsequent older fish in the mainstem Kootenai River. These populations are at least partly dependent on recruitment from Montana waters. The low recruitment and high exploitation rate may be indicators of a rainbow trout population in danger of further decline.

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## INTRODUCTION

The Kootenai River has undergone the recent loss of several once relatively productive fisheries (white sturgeon *Acipenser transmontanus*, burbot *Lota lota*, bull trout *Salvelinus confluentus*, kokanee *Oncorhynchus nerka*, and mountain whitefish *Prosopium williamsoni*). The trout (rainbow *O. mykiss* and westslope cutthroat *O. clarki lewis*) fishery has also declined. Partridge (1983) estimated angler catch rates of 0.06 trout/h in 1982 and 1983, while Paragamian (1995a) reported angler catch rates of 0.02 trout/h in 1993 and 1994. In comparison, Schill (1991) summarized catch rates for a number of Idaho rivers, which ranged from 0.7 to 1.95 trout/h. Currently, despite low densities and catch rates, rainbow trout provide the most important fishery in the Kootenai River (Paragamian 1995a).

Rainbow trout densities and standing stocks in the Kootenai River are low. Rainbow trout densities of 3, 5, and 7 fish/ha were reported for 1993, 1994, and 1998 respectively, with standing stocks of 0.67, 1.66, and 1.62 kg/ha for the same years (Paragamian 1995a and b; Downs 2000). These low densities are hypothesized to result from limited juvenile recruitment to the mainstem (Partridge 1983; Fredericks and Hendricks 1997). Partridge (1983) and Paragamian (1994a) suggested the rainbow trout recruitment source is primarily from tributaries. Since their work, recruitment (i.e. number of juvenile out-migrants) has been quantified only from the Deep Creek drainage (Fredericks and Hendricks 1997; Downs 1999, 2000). Contribution from other Idaho tributaries remains unknown, and no studies have documented rainbow trout spawning in the mainstem Kootenai River in Idaho.

A second hypothesis explains low rainbow trout densities by the decrease in productivity of the Kootenai River since Libby Dam went into operation in 1974 (Paragamian 1995a). Plans are being formulated to test this hypothesis in 2002-2003. The present study will provide important baseline data for the testing of the “nutrient limitation” hypothesis.

Columbia River basin bull trout were listed in the Federal Register as threatened on June 10, 1998. Little is known about bull trout in the Kootenai River. Tributary surveys have documented few fish, but adults have been caught in the mainstem while sampling for other species. More information, especially on life history characteristics, is needed to help recover this population. Determining bull trout spawning locations and recruitment sources would be a beneficial first step in adding to this knowledge base.

### Research goal

- 1) Provide a management plan to improve the rainbow trout fishery, and
- 2) Provide management recommendations to restore the bull trout population(s).

### Objectives

- 1) Determine sources of rainbow and bull trout recruitment to the Idaho reach of the Kootenai River.
- 2) Determine rainbow trout population characteristics important to management including angler exploitation rate, population density, and growth rates.

To address these objectives, we estimated the contribution of juvenile trout out-migrating from Boundary Creek, a tributary of the Kootenai River at the U.S.-Canada border at river kilometer (rkm) 170 (Figure 1). In addition, we surveyed other Idaho tributaries to the Kootenai River to estimate juvenile trout abundance. We also monitored radio-tagged rainbow and bull

trout to determine movement patterns and potential spawning locations, and we marked rainbow trout with angler reward tags to document movement and angler exploitation rate. In September, we conducted mark-recapture population estimates for salmonids inhabiting the Hemlock Bar reach of the Kootenai River. While conducting population estimates, we also collected data on population age structure, standing stock, and condition factors. In October, we conducted salmonid redd counts in tributaries entering the Kootenai River from the west, downstream of Bonners Ferry (Figure 1).

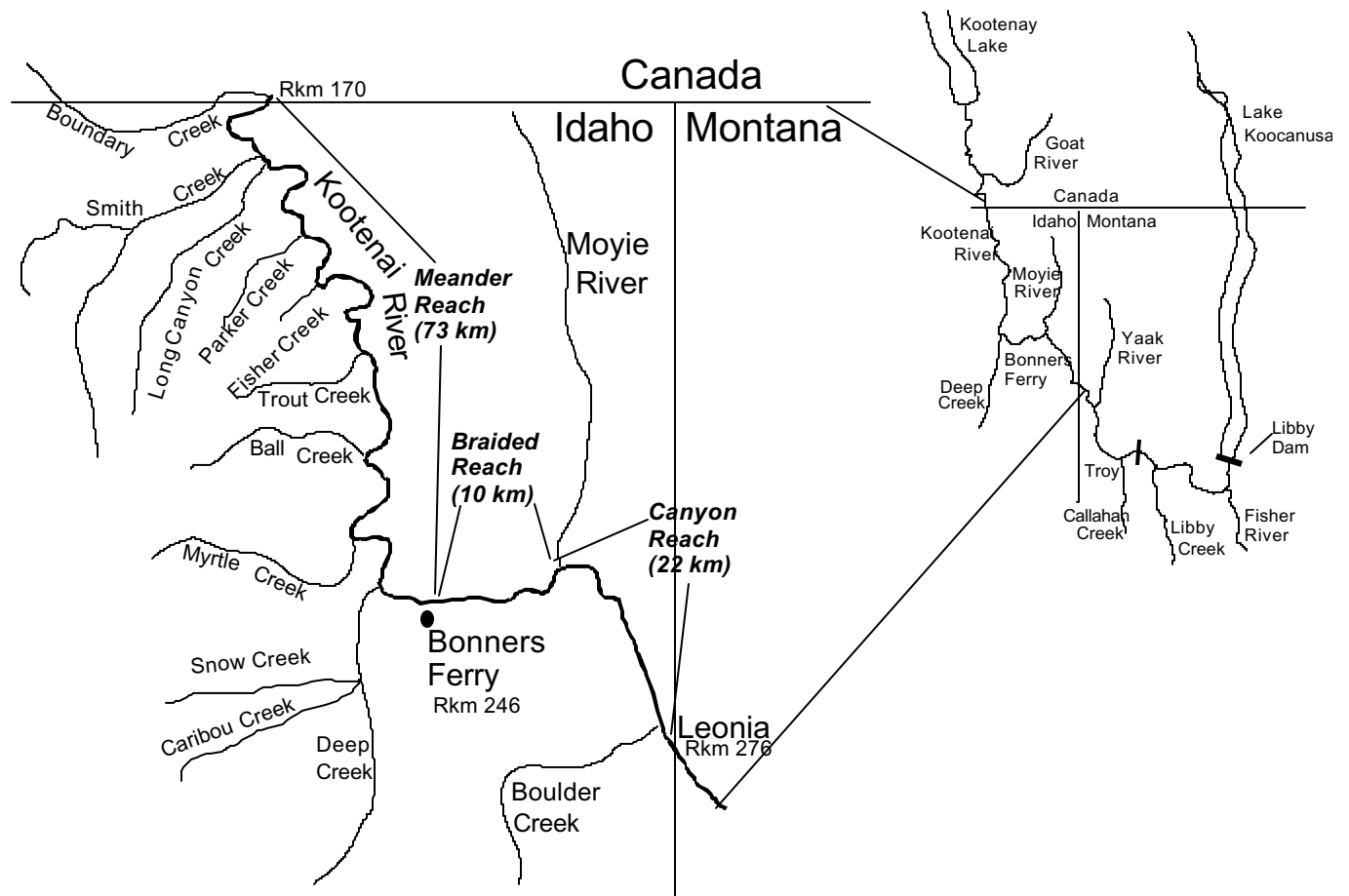


Figure 1. The Kootenai River and some tributaries in Idaho (modified from Fredericks and Hendricks 1997).

## STUDY AREA

There are approximately 105 km of Kootenai River in Idaho with the following three distinct reaches: 1) the canyon reach (22 km) from the Montana border to the Moyie River, 2) the braided reach (10 km) from the Moyie River to Bonners Ferry, and 3) the meandering reach (73 km) from Bonners Ferry to the Canadian border (Fredericks and Hendricks 1997) (Figure 1). The meandering reach has been heavily altered by diking and has substrates consisting mainly of sand, silt, and clays (Partridge 1983). Based on substrate and depth, the braided and canyon reaches upstream of Bonners Ferry appear to be the most suitable adult fluvial rainbow trout habitat (Partridge 1983). The Kootenai River in Montana, up to Kootenai Falls, is also accessible to fluvial trout. Kootenai Falls, at rkm 310, is a presumed migration barrier (Chapman and May 1986).

Major Kootenai River tributaries in Idaho include Boundary and Deep creeks downstream of Bonners Ferry, and Boulder Creek and the Moyie River upstream of Bonners Ferry. There is about 0.5 km of potential rainbow trout spawning gravel in Boundary Creek where it enters the Kootenai River valley. The upstream canyon portion has a boulder-rubble substrate with pockets of gravel. Grass Creek, the major tributary to Boundary Creek, has some of the better spawning gravels of tributaries accessible to salmonids from the Kootenai River (Partridge 1983).

Numerous smaller Kootenai River tributaries are present, though most have natural or man-made migration barriers within 5 km of their mouths. Many of these smaller tributaries have been channelized, further limiting salmonid spawning habitat (Partridge 1983). Major tributaries in Montana downstream of Kootenai Falls include O'Brien and Callahan creeks (Figure 1).

## METHODS

### Boundary Creek Out-migrants

We used a rotary-screw trap to capture juvenile trout out-migrating from Boundary Creek from March 16 to August 23, 1999 (Thedinga et al. 1994; Kennen et al. 1994). The trap was located in the SW ¼ of Section 11, Township 65 N., Range 2 W, just downstream of the United States Geological Survey (USGS) gauging station.

Trapped trout were weighed (g) and measured (total length [TL], mm). These fish were then marked with a caudal clip, moved 250 m upstream of the screw trap, and released to estimate trap efficiency (Thedinga et al. 1994). All other species were weighed and measured and released downstream of the trap.

We estimated trap efficiency for juvenile trout by mark-recapture (Seelbach et al. 1985; Kennen et al. 1994; Thedinga et al. 1994; Roper 1995). We used software developed by the National Marine Fisheries Service-Auke Bay Laboratory to estimate trap efficiency and number of rainbow trout juveniles emigrating past the trap (M. L. Murphy, Auke Bay Laboratory, personal communication). The software calculates trap efficiency as follows:

$$\hat{E} = \frac{R+1}{M+1}$$

where  $\hat{E}$  = trap efficiency,  $R$  = number of marked fish recaptured, and  $M$  = number of marked fish released above the trap. The software then uses the bootstrap method to estimate the number of emigrants passing the trap (Efron and Tibshirani 1986, 1993; Murphy et al. 1992; Thedinga et al. 1994). We ran 1,000 iterations to obtain the estimate. We then determined 95% confidence intervals for the estimate, based on the percentiles of the bootstrap distribution (Buckland 1984; Efron and Tibshirani 1993; M. L. Murphy, Auke Bay Laboratory, personal communication).

Before calculating the estimate, we expanded the number of unmarked fish caught to include days when the trap was not fished. We also included marked and recaptured fish numbers in our estimate only for those periods when the trap was operated for at least four consecutive days post-release of marked fish (Downs 2000). Due to the low numbers of juvenile rainbow trout trapped, we conducted a single estimate for the entire trapping period.

Potential biases may arise when calculating trap efficiency if marked fish are lost from the population. This situation may arise from mortality of marked fish or residualization of marked fish released above the trap. The effects of handling mortality and residualization on trap efficiency were found to be insignificant in a previous study and are assumed negligible here (Downs 2000).

Age and mean TL at out-migration was estimated from the analysis of scales collected from 10 juvenile rainbow trout per 10 mm length interval during screw trap operations. Scales were collected from the area immediately dorsal to the lateral line and slightly anterior to the insertion of the adipose fin. Scales were impressed onto plastic slides and aged using a microfiche reader at 42X.

Water temperature was monitored with an electronic temperature logger deployed at the screw trap from March 2 to July 12, 1999. After July 12, water temperatures were recorded with a thermometer each day the trap was checked for the remainder of the trapping season. We monitored relative stream discharge with a staff gauge located at the screw trap.

## **Radio Telemetry**

We electrofished the Kootenai River (rkm 254-275.5) in fall 1998 and spring 1999 to collect rainbow and bull trout for radio tagging. Additional bull trout were collected from a weir trap box on O'Brien Creek, Montana in fall 1999. We followed tagging protocols and surgery procedures described by Downs (2000). Low-frequency (30 – 31Mhz.) radio-tags (transmitters) were used to maximize signal transmission in the deep, oligotrophic waters of the Kootenai River (Winter 1996; Downs 2000). Five different transmitter types were used (Table 1). All transmitters were active for 8 h and off for 16 h each day. Signals were at the rate of 40 pulses per minute (ppm). Telemetry was conducted from 0800-1600 h by fixed-wing aircraft and by boat. We searched for radio-tagged fish about once every one to two weeks.

Table 1. Weights, duty cycle, and tag life expectancy for radio-transmitters implanted into rainbow and bull trout in the Kootenai River drainage. All tags were active 8 h/d and off 16 h/d.

Tag Weight (g)	Duty Cycle	Tag Life Expectancy (d)
7.35-8.2	90 d on, 90 d off, 160 d on	250
7.9-8.2	On every day	200
10-11	On every day	360
18.36-18.81	On every day	730
25.1-25.3	On every day	912

Our objective was to monitor potential spawning migration in an attempt to document spawning areas. We defined rainbow trout spawning migration as movement into a tributary stream in spring (late March to June), or an upstream movement of  $\geq 0.5$  km in spring relative to the last location in fall or early spring (up to March 22), followed by movement back downstream. We defined bull trout spawning migration as movement into or out of a tributary stream from June 1 to October 30, or an upstream movement of  $\geq 10$  km during that same period.

### Reward Tagging

To gain additional movement data, we marked rainbow trout  $\geq 225$  mm TL with \$10.00 reward T-bar anchor style tags. Ninety-five rainbow trout were tagged in the Kootenai River from Crossport (rkm 254) to the Boulder Creek confluence (rkm 275.5) (Figure 2). Two additional rainbow trout were tagged near Copeland (rkm 199.5). These fish were captured by electrofishing from July 6 to 21, 1999. The rainbow trout were weighed (g), measured (TL in mm), and tagged, and a scale sample was removed before being released.

Angler exploitation of rainbow trout tagged from rkm 254.5 to 275 was also quantified through angler returns of the reward tags. We advertised the reward-tag program by posting signs at fishing access sites on the Kootenai River in Idaho and Montana, and Kootenay Lake, British Columbia. In addition, press releases were published in local newspapers.

In June 1999, we marked 34 hatchery rainbow trout (201-348 mm TL) with T-bar anchor style tags and held the fish in a hatchery raceway to monitor tag retention. Tag retention was evaluated in July, August, and October 1999.

Angler exploitation was estimated as the number of reward tags returned divided by the number of reward tags available in the fishery. The number of reward tags available was corrected for tag loss based on our tag retention study. The number of returned reward tags was corrected for non-response by utilizing a linear-logistic model developed for estimating band reporting rates of mallard ducks *Anas platyrhynchos* (Nichols et al. 1991) as:

$$\lambda_i = \exp(-0.0045 + 0.0283i) / [1 + \exp(-0.0045 + 0.0283i)]$$

where:

$\lambda_i$  = estimated reporting rate for reward dollar amount  
 $i$  = reward dollar amount

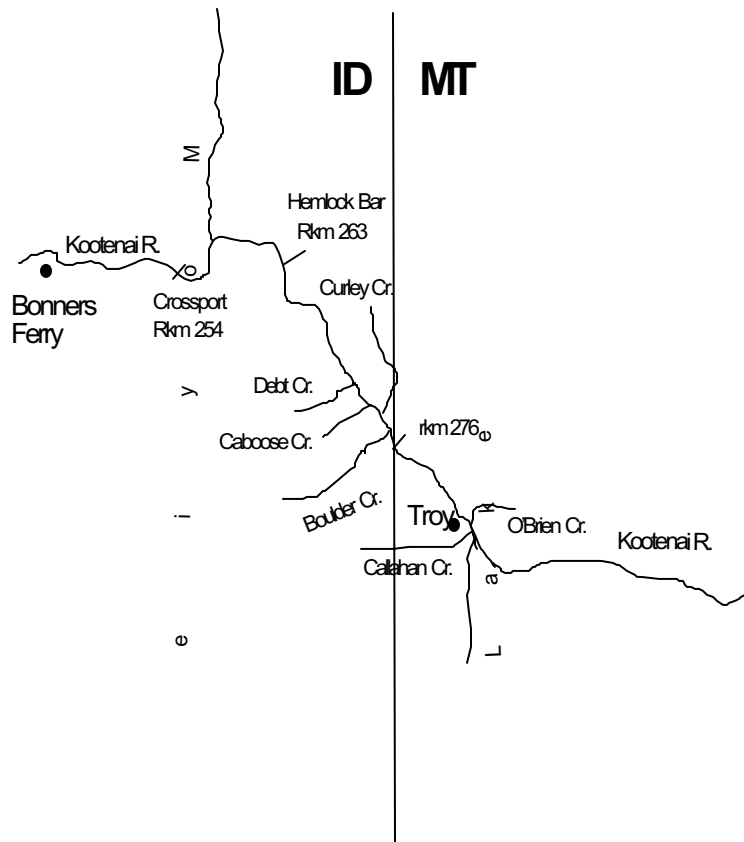


Figure 2. Kootenai River mainstem and tributaries where radio-tagged trout were located or where snorkeling and electrofishing occurred in 1999 (rkm = river kilometer).

### Kootenai River Tributary Recruitment Assessment

We conducted multiple-pass depletion estimates in selected reaches of Boulder, Caboose, Curly, and Debt creeks below migration barriers to estimate potential recruitment to the Kootenai River (Figure 2) (Downs 2000). The estimates were conducted using a Smith-Root model 11-A backpack electrofisher.

Multiple pass depletion data were analyzed using the Microfish software package (Van Deventer and Platts 1989). Where depletion estimates were not possible, single pass electrofishing runs were conducted, and catch-per-unit-effort was used to index abundance. Each fish was weighed (g) and measured (TL in mm), then released back into the stream after sampling was completed.

We also conducted a snorkel survey in Boundary Creek in August 1999 to determine rainbow trout density. Two sites downstream of the screw trap location were snorkeled, covering 7,037 m<sup>2</sup>. An additional site starting at the screw trap and moving through the third riffle upstream was also snorkeled, but the area was not measured. Snorkelers proceeded in an upstream direction, counting all trout species seen by length intervals. Length intervals included <75 mm TL (young of year), 75-150 mm TL, and >150 mm TL.

### **Kootenai River Fish Population Assessment**

Mark-recapture population estimates targeting rainbow trout and mountain whitefish were conducted in the Hemlock Bar reach (29.4 ha; rkm 262–265) of the Kootenai River from September 13 to 21, 1999, following the methods of Downs (2000). All other species seen were also netted, with the exception of kokanee, which were only netted the first night. Captured fish were weighed (g), measured (TL in mm), marked with a fin clip, and released. Marking was conducted over a three-night period, and the recapture run was conducted over a two-night period the following week.

Population estimates were calculated using the modified Petersen method for sampling without replacement as follows (Seber 1982; Krebs 1989):

$$N = ([M+1] [C+1] [R+1]) - 1$$

Where:

N = the population estimate

M = the number of fish marked

C = the number of fish in the recapture sample

R = the number of recaptures in the recapture sample

Rainbow trout and mountain whitefish estimates were stratified into length groups because the size-selective nature of electrofishing can introduce bias into population estimates (Anderson 1995; Reynolds 1996). Binomial confidence intervals were calculated as recommended by Seber (1982) using the chart provided by Krebs (1989). Relative weights ( $W_r$ ) and proportional stock density (PSD) were calculated to assess rainbow trout condition and population size structure, respectively (Anderson and Neumann 1996). Stock structure indices were estimated from the marking sample and separated into two classes: proportion >305 mm TL and the proportion >406 mm TL (quality stock density) (Anderson 1980; Schill 1991). The indices were calculated for fish >200 mm TL (stock length; Anderson 1980; Schill 1991).

A sample of scales was collected from each rainbow trout captured for estimation of age and growth. Scales were impressed onto plastic slides and viewed on a microfiche reader at 42X. A regression of TL at capture on scale radius ( $Y = 3.7[X] + 77.4$ ;  $R^2 = 0.71$ ,  $P < 0.001$ ) was used with a refined Whitney and Carlander (1956) “body proportional” method (Francis 1990) to back-calculate TL at age. The Francis (1990) method uses:

$$L_i = ([c + dS_i] [c + dS_c]) L_c$$

Where:

$L_i$  = TL

$S_i$  = radius measurement at time of formation of the  $i$ th annulus

$L_c$  = the TL at capture

$S_c$  = total scale radius

$c$  = the y-intercept from the regression equation

$d$  = slope derived from the regression equation

Mean length at age and annual growth increments were estimated from the back-calculation data.

### **Kootenai River Juvenile Salmonid Shoreline Abundance Index**

Single-pass electrofishing runs were conducted in July and August to index the abundance of juvenile salmonids in the mainstem Kootenai River. Electrofishing was conducted in a stratified pattern along the shoreline from rkm 255 (Crossport area) to rkm 272 (Curley Creek). We defined the shoreline as the zone extending out from the riverbank into the river for a distance of 1 m. We sampled the downstream most 60-130 m of shoreline habitat on each bank within each rkm, for 3,391 m<sup>2</sup> of shoreline. The catch per unit effort (number of fish/m<sup>2</sup>) for age-0 rainbow trout was then expanded to estimate a total catch for rkm 250-275 (52,000 m<sup>2</sup> of shoreline habitat) (Downs 2000). This total expanded catch was then divided by 0.25 (estimated electrofishing efficiency; Downs 2000) to estimate the total number of age-0 rainbow trout in the study reach.

Electrofishing was conducted using a mobile electrofishing system consisting of a hand-held anode, Coffelt VVP-15 electrofisher, and a 5,000 W Honda generator. The shocking equipment was placed in an aluminum jetboat, which served as the cathode. Two individuals walked downstream with the mobile anode and a dip net, capturing fish as they were stunned. A third individual held the boat, walking it downstream as needed. Smooth DC current generating between 2 and 4 amps at 200-250 volts was used to stun the fish.

Captured juvenile (<225 mm TL) salmonids were weighed (g) and measured (TL in mm). Rainbow trout <70 mm TL were classified as age-0 (Downs 2000). Water temperature was recorded at each sample site.

### **Hoop Netting**

Hoop nets were fished in the Kootenai River to collect bull trout for radio tagging. Three nets were set at rkm 240.4 on April 19-20, 1999 for a net h effort of 94. Four hoop nets were set at rkm 204 on August 18-19, 1999 for a net h of 92.

### **Redd Surveys**

Kootenai River tributaries downstream of Bonners Ferry with potential bull trout spawning habitat were hiked in October, 1999 to survey for salmonid redds (Figure 1; Table 2). One observer hiked a single pass along each stream transect, looking for bull trout, kokanee, and redds.

Table 2. Kootenai River tributaries surveyed for bull trout and kokanee redds, October 1999.

Creek	Date Surveyed	Upstream Boundary	Downstream Boundary
Snow	10/5	Base of falls	Near mouth
Ball	10/13	Westside Road	Slackwater
Fisher	10/13	Bridge on Westside Road	Slackwater
Long Canyon	10/13	Bridge on Westside Road	Slackwater
Myrtle	10/13	Base of falls	Slackwater
Parker	10/13	Bridge on Westside Road	Slackwater
Boundary	10/18	2 mi. marker up Forest Road 2450 (including side and main channels)	Slackwater
Caribou	10/19	City water diversion (approx. 2.5 km upstream of bridge)	Mouth at Snow Creek

## RESULTS

### Boundary Creek Out-migrants

A total of 119 rainbow trout out-migrants were caught in the screw trap from March 16 to August 23, 1999. The juvenile rainbow trout trap efficiency was 0.12. An estimated 1,574 (95% CI = 825-3,283) juvenile rainbow trout out-migrated from the Boundary Creek drainage during the trapping period. Water temperatures during trap operation ranged from 2°C to 17°C, with mean weekly temperatures remaining below 16°C (Figure 3). Rainbow trout out-migrants were comprised mainly of age-2 and age-3 fish (Table 3). No bull trout out-migrants were collected.

Table 3. Mean total length (TL) by age group for rainbow trout out-migrants from Boundary Creek, March-August, 1999.

Age Class <sup>a</sup>	N	Mean TL (mm)	S. E.	Proportion
1	3	69	4	0.03
2	43	135	2	0.45
3	44	162	2	0.46
4	6	177	4	0.06

<sup>a</sup> Three additional age-4 fish were caught but not included here, as they were assumed to be spawning adults and not out-migrants because of their relatively large size.

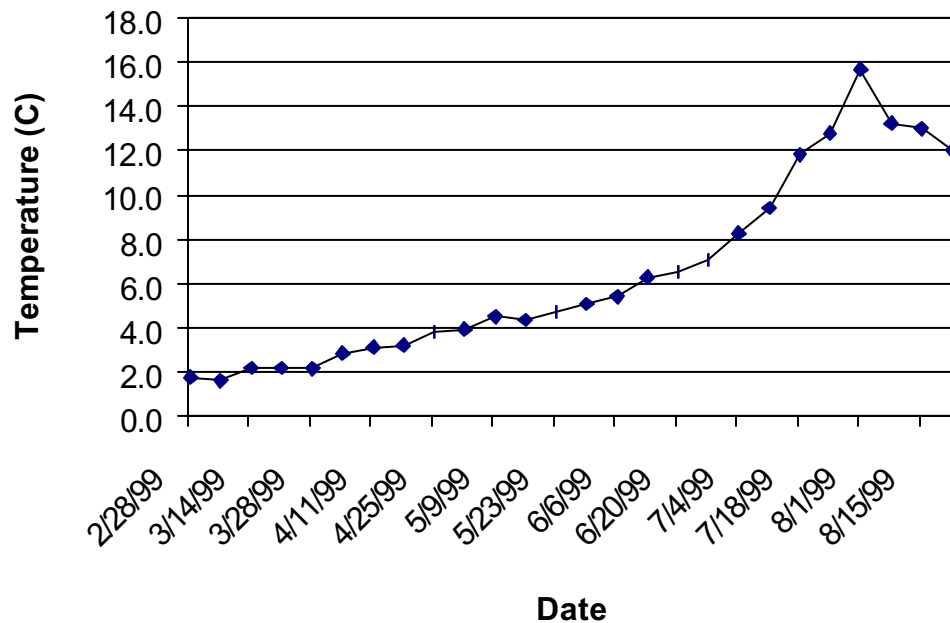


Figure 3. Mean weekly water temperatures for Boundary Creek, February 28-August 22, 1999.

## Radio Telemetry

We collected and radio-tagged 19 rainbow trout in fall 1998 and four rainbow trout in March 1999 (Table 4). Two of these fish are not included in our analyses as we lost contact with them within two weeks of tagging. Twelve of the 17 radio-tagged rainbow trout located during the 1999 spawning season (March-June) showed apparent spawning migrations (Appendix A). Six of these 17 fish were located in tributary streams including Caboose (one fish) and Boulder (two fish) creeks in Idaho, and Lake (two fish) and Callahan (one fish) creeks in Montana (Figure 2). In the mainstem Kootenai River, two rainbow trout migrated up to the Kootenai Falls area. There were no other areas where radio-tagged rainbow trout congregated during the spawning season. Three rainbow trout we monitored during winter and early spring 1999 each moved less than 2 km (Appendix A).

Four bull trout were caught by electrofishing and radio tagged—three in 1998 and one in 1999. Eight bull trout were radio tagged from the O'Brien Creek weir (Table 4). Eleven of the 12 bull trout monitored during the 1999 spawning season showed spawning migrations (Appendix A). All three of the bull trout radio tagged in 1998 moved upstream from Idaho into Montana waters during the 1999 spawning season, including one fish which ascended O'Brien Creek. All eight fish tagged in O'Brien Creek moved into the Kootenai River by the end of October. Two of these fish moved upstream of O'Brien Creek, while one moved just downstream of O'Brien Creek, where they remained through December. Four of the other five fish tagged in O'Brien Creek moved downstream into Idaho, while one moved downstream to the south arm of Kootenay Lake, British Columbia (rkm 120). The bull trout tagged near Hemlock Bar in September 1999 did not show spawning migration movements.

## Reward Tagging

From July 21, 1999 to July 20, 2000, anglers reported harvesting 25 (26%) of the 95 rainbow trout tagged between Crossport and Boulder Creek (Figure 2). Our tag retention study showed that 79% of the hatchery rainbow trout retained their tags as of October 4, 1999, 108 d after tagging. Using this estimate to correct for tag loss, the minimum annual angler exploitation rate was 33%. When correcting for angler non-response of harvested, tagged fish, the estimated annual angler exploitation rate was 58%. Seven additional tagged fish were known to be caught by anglers and released. When applying the same correction factors as above, an estimated 75% of the tagged fish were handled (harvested or caught and released) by anglers.

The numbers of floy-tagged fish harvested by month were as follows: June-2, July-11, August-8, September-3, and October-1.

## Kootenai River Tributary Recruitment Assessment

Electrofishing depletion population estimates and catch-per-unit-effort indices are reported in Table 5. The following numbers of fish were seen while snorkeling downstream of the Boundary Creek screw trap: one brook trout *S. fontinalis* <75 mm TL, four rainbow trout <75 mm TL, 31 rainbow trout 75-150 mm TL, nine rainbow trout >150 mm TL, 97 mountain whitefish 75-150 mm TL, and six mountain whitefish >150 mm TL. Upstream of the screw trap, we observed 11 rainbow trout 75-150 mm TL, four rainbow trout >150 mm TL, 55 mountain whitefish 75-150 mm TL and 11 mountain whitefish >150 mm TL.

Table 4. Summary of telemetry data and physical characteristics for rainbow (Rbt) and bull (Bullt) trout radio tagged in the Kootenai River, Idaho and O'Brien Creek, Montana, September 1998 to October 1999. nm = not measured, u = unknown, f = female, m = male.

Species	Radio Frequency	Tag Date	Tag Location (rkm)	Total Length (mm)	Weight (g)	Sex	Expected Tag Expiration Date	Last Location Date Through 1999
Rbt	30.522	9/15/98	262.5	413	680	u	8/28/99	9/28/99
Rbt	30.682	9/15/98	262.5	409	680	u	8/28/99	8/31/99
Rbt	30.120	9/17/98	262.5	419	539	u	8/30/99	9/28/99
Rbt	30.140	9/21/98	270.0	417	624	u	9/4/99	9/28/99
Rbt	30.541	9/21/98	271.5	389	482	u	9/4/99	9/28/99
Rbt	30.641	9/21/98	270.0	367	454	u	9/4/99	7/12/99
Rbt	30.742	9/21/98	271.5	409	652	u	9/4/99	6/21/99
Rbt	30.792	9/21/98	271.5	381	454	u	9/4/99	9/28/99
Rbt	30.573	9/22/98	263.0	377	454	u	4/11/99	9/28/99
Rbt	30.583	9/22/98	268.0	407	624	u	4/11/99	3/15/99
Rbt	30.633	9/22/98	266.0	402	539	u	4/11/99	9/28/99
Rbt	30.772	9/22/98	266.0	421	652	u	9/5/99	9/28/99
Rbt	30.552	9/24/98	254.0	386	425	u	9/7/99	11/16/98
Rbt	30.722	9/24/98	257.5	426	680	u	9/7/99	9/28/99
Rbt	30.180	10/1/98	275.5	383	539	u	9/14/99	9/28/99
Rbt	30.562	10/1/98	272.5	386	454	u	9/14/99	4/8/99
Rbt	30.612	10/1/98	272.5	359	454	u	9/14/99	9/28/99
Rbt	30.701	10/1/98	275.5	391	539	u	9/14/99	9/28/99
Rbt	30.592	3/10/99	274.5	403	454	u	2/19/00	6/21/99
Rbt	30.312	3/30/99	264.0	465	822	u	3/9/00	4/12/99
Rbt	30.503	3/30/99	264.0	439	666	u	10/20/99	7/12/99
Rbt	30.602	3/30/99	264.0	422	567	u	3/10/00	4/5/99
Bullt	30.452	9/10/98	262.5	458 <sup>a</sup>	1021	u	9/5/99	12/14/99
Bullt	30.623	9/24/98	256.0	580 <sup>a</sup>	2438	u	9/19/99	12/14/99
Bullt	30.711	10/1/98	275.5	750 <sup>a</sup>	5500	u	9/26/99	12/14/99
Bullt	30.241	9/15/99	262.5	459	1077	u	9/15/01	12/14/99
Bullt	30.654	10/1/99	301.2 <sup>b</sup>	711	nm	f	4/1/02	12/14/99
Bullt	31.423	10/8/99	301.2 <sup>b</sup>	838	nm	m	5/8/02	12/14/99
Bullt	30.191	10/8/99	301.2 <sup>b</sup>	800	nm	m	10/8/01	12/14/99
Bullt	30.333	10/8/99	301.2 <sup>b</sup>	762	nm	f	4/8/02	12/14/99
Bullt	30.031	10/8/99	301.2 <sup>b</sup>	705	nm	m	10/8/01	12/14/99
Bullt	30.251	10/8/99	301.2 <sup>b</sup>	737	nm	m	10/8/01	12/14/99
Bullt	30.394	10/8/99	301.2 <sup>b</sup>	775	nm	m	4/8/02	12/14/99

<sup>a</sup> Fork Length

<sup>b</sup> Tagged and released in O'Brien Creek, Montana

Table 5. Multi-pass depletion estimates and abundance indices for Kootenai River tributaries, summer 1999. Acronyms as follows: Sls = slimy sculpin *Cottus cognatus*, Rbt = rainbow trout, Mwf = mountain whitefish, Bullt = bull trout, Brkt = brook trout, nm = not measured.

Stream	Species	Stream Section	Number Captured On First Pass	Total Number Caught	Area Sampled m <sup>2</sup>	% of Total Catch Which Were Age 0	Population Estimate	Lower 95% C. L.	Upper 95% C. L.	CPUE n/m <sup>2</sup>
Boulder Cr.	Mwf	Lower	1	2	nm	100	2	0	15	—
	Rbt	Lower	5	6	nm	83	6	5	7	—
	Rbt	Upper	1	1	nm	100				—
Caboose Cr.	Rbt	Mouth to culvert	41	88	123	93	102	86	118	0.33
	Bullt	Mouth to culvert	2	2	123					0.02
	Brkt	Mouth to culvert	2	5	123		5	3	7	0.02
	Sls	Mouth to culvert	0	1	123					
Curly Cr.	Rbt	Immediately above culvert	20	43	306	58	55	35	75	0.07
	Rbt	Mouth up 100 m	6	14	500	50	16	8	24	0.01
	Brkt	Mouth up 100 m	6	10	500		10	8	12	0.01
	Mwf	Mouth up 100 m	6	11	500		11	8	14	0.01
Debt Cr.	Rbt	Upper	34	67	220	87	76	64	88	0.15
	Rbt	Lower	18	73	189	92	257	0	797	0.10
	Bullt	Lower	1	1	189					0.01

## Kootenai River Fish Population Assessment

Nine species of fish and a hybrid were caught during fall electrofishing of the Hemlock Bar reach (Table 6). Population estimates, densities, and standing stocks for largescale sucker *Catostomus macrocheilus*, mountain whitefish, and rainbow trout were also calculated for the fall electrofishing sample (Table 6). Estimated relative weights ( $W_r$ ) for rainbow trout size groups 201-305 mm TL, 306-406 mm TL, and >406 mm TL were 95 (SE = 2), 86 (SE = 1), and 81 (SE = 4), respectively. Rainbow trout proportional stock and quality stock densities were 47% and 3%, respectively.

Length at age estimates for rainbow trout captured in the fall are given in Table 7. Maximum age was six, but 93% of the rainbow trout captured were  $\leq$ age-4.

Table 6. Summary of electrofishing results for the Hemlock Bar reach of the Kootenai River, fall 1999. Acronyms as follows: Bullt = bull trout, Kok = kokanee, Lss = large-scale sucker *Catostomus macrocheilus*, Lnd = longnose dace *Rhinichthys cataractae*, Lns = longnose sucker *Catostomus catostomus*, Mwf = mountain whitefish, Npm = northern pikeminnow *Ptychocheilus oregonensis*, Rbt = rainbow trout, Rss = redbreasted shiner *Richardsonius balteatus*. Size is total length.

Species	Length Range Caught (mm)	Number Caught <sup>b</sup>	Population Estimate	95% C. L.	Standing stock and density			
					n/ha	kg/ha	n/km	kg/km
Bullt	257-459	2						
Kok <sup>a</sup>	215-245	54						
Lss	105-680	166	1754	770-3860	59.7	54.0	585	529.5
Lnd	65	1						
Lns	205-540	18						
Mwf	79-129	10						
	130-219	210	3699	1754-10560	125.8	7.4	1233	72.9
	220-519	568	3686	2524-5557	125.4	27.4	1229	268.1
Npm	202-630	33						
Rbt	83-179	7						
	180-249	42	68	40-177	2.3	0.2	23	2.4
	250-349	64	87	60-165	3.0	0.8	29	7.4
	350-415	22	35	20-283	1.2	0.6	12	5.6
Rss	96-125	2						
Trout Hybrid <sup>c</sup>	376-380	2						

<sup>a</sup> kokanee were netted on 9/13 only

<sup>b</sup> includes recaptures

<sup>c</sup> rainbow trout X westslope cutthroat trout

Table 7. Back-calculated total length (TL, mm) and standard error (SE) at age for rainbow trout sampled while electrofishing the Hemlock Bar reach of the Kootenai River, Idaho in September 1999.

Rainbow Trout Age at Capture	N	Mean TL at Capture	TL Range At Capture	Mean Back Calculated TL at:											
				Age-1	SE	Age-2	SE	Age-3	SE	Age-4	SE	Age-5	SE	Age-6	SE
1	9	181	120-211	116	6										
2	28	231	120-309	127	4	183	7								
3	15	304	236-390	128	4	191	11	258	14						
4	10	353	307-407	125	4	182	10	237	12	299	10				
5	3	349	318-370	127	11	165	17	202	22	237	32	314	22		
6	2	374	372-375	140	4	201	2	235	1	269	0	316	12	354	3
Weighted Mean				126	1	185	1	244	3	283	7	315	1	354	0
Increment				126		59		59		39		32		40	
N				67		58		30		15		5		2	

## Kootenai River Juvenile Salmonid Shoreline Abundance Index

We sampled four species of juvenile salmonids, with rainbow trout the most common species collected (Table 8). Water temperatures ranged from 15°C-17°C during sampling. Catch per unit effort for age-0 rainbow trout was 0.009/m<sup>2</sup>. The expanded catch for rkm 250-275 is 468 age-0 rainbow trout. The estimated number of age-0 rainbow trout inhabiting the study reach is 1,872.

Table 8. Relative abundance, mean total length (TL, mm) and length ranges for juvenile salmonids captured by electrofishing in the Kootenai River, Idaho, river kilometer 255-272, July-August, 1999.

Species	Number Captured	Mean TL (SE)	Length Range (mm)
Brook Trout	2	68 (10)	58-77
Bull Trout	1	64 (-)	—
Mountain Whitefish	3	78 (1)	77-80
Rainbow Trout (Age-0)	30	37 (2)	21-67 <sup>a</sup>

<sup>a</sup> Four additional juvenile rainbow trout were caught ranging from 100-140 mm.

## Hoop Netting

Two northern pikeminnow and one yellow perch *Perca flavescens* were the only fish caught in the hoop net sets during April. No fish were caught in the hoop net sets during August.

## Redd Surveys

No bull trout, kokanee, or their redds were observed during October redd surveys.

## DISCUSSION

### Boundary Creek Out-migrants

The estimated recruitment of 1,574 juvenile rainbow trout from Boundary Creek was low compared to an average of 37,198 recruits from Deep Creek for 1997 and 1998 (Downs 1999, 2000). Most Boundary Creek rainbow trout out-migrated at age-2 or age-3, which also contrasts to the Deep Creek drainage where most out-migrants were age-1 and age-2 (Downs 2000). The older age at out-migration for Boundary Creek may be a result of the colder water temperatures leading to slower growth as compared to Deep Creek (Downs 2000).

## **Radio Telemetry**

A fluvial population of rainbow trout inhabits the Kootenai River upstream of Bonners Ferry. We have no evidence to indicate adfluvial fish from Kootenay Lake spawn in this section of the river or its tributaries as they do in Deep Creek (Downs 2000). Some anglers have reported a spring run of relatively large fish in the river, which they believe came from Kootenay Lake. Therefore, some adfluvial fish may occur upstream of Bonners Ferry during the spring. Increasing the sample size of radio-tagged rainbow trout, including more fish tagged in early spring before spawning, may help quantify the adfluvial fish component.

Radio telemetry also showed that the Kootenai River and some of its tributaries in Montana are utilized during the spawning season by rainbow and bull trout that normally reside in Idaho. This supports Downs' (2000) hypothesis that the fluvial rainbow trout population in Idaho is supplemented by recruitment from fish spawned in Montana. Protection and enhancement of spawning habitat in Montana should be an important consideration in managing the Idaho Kootenai River rainbow trout fishery and for bull trout conservation. Monitoring of additional radio-tagged rainbow and bull trout may help identify other spawning tributaries and the presence of spawning habitat in the mainstem Kootenai River. Monitoring radio-tagged bull trout will also provide additional life history information (e.g. winter habitat use, spawning migration timing) for the Kootenai River population, which we know little about.

## **Reward Tagging**

Annual angler exploitation of rainbow trout in the Kootenai River upstream of Bonners Ferry is high. Continued high exploitation of rainbow trout, along with limited recruitment, may further contribute to a decreasing trend in the population. As the density is already low relative to many other fluvial rainbow trout populations in Idaho (Schill 1991), managers should consider options to prevent any declines in the population. Annual angler exploitation rates should continue to be monitored, because there is the possibility that the rate measured in 1999 did not reflect the norm for this reach of the river.

## **Kootenai River Tributary Recruitment Assessment**

Rainbow trout reproduction was documented by electrofishing in Boulder, Caboose, Curley, and Debt creeks in 1999. Similarly, Downs (2000) reported this reproduction is minimal and does not account for subsequent densities of older rainbow trout in the mainstem. However, there may be opportunities to enhance tributary spawning habitat or spawner access. For example, Caboose Creek has a railroad culvert 37 m upstream from its mouth, which may block rainbow trout spawning migrations (Partridge 1983; Downs 2000). Some type of passage improvement may allow rainbow trout adults to access additional spawning habitat. It may be possible to construct a spawning and rearing channel near the mouth of Boulder Creek (Partridge 1983). Constructing some type of spawning channel on the Moyie River is another possibility.

Juvenile bull trout were documented in Caboose and Debt creeks in 1999. Presence of a threatened species in these streams indicates potentially suitable habitat, although densities are low. Habitat enhancement (e.g., gravel supplementation, removal of migration barriers) may benefit bull trout spawning and recruitment. However, habitat modifications should be considered carefully. For example, modifications to benefit bull trout may also benefit the

non-native brook trout, a species that has been implicated in declining bull trout populations (e.g., through hybridization) (Kitano et al. 1994).

## **Kootenai River Fish Population Assessment**

The 1999 population estimate of 190 rainbow trout in the Hemlock Bar reach of the Kootenai River was similar to the 1998 estimate of 219 fish. Rainbow trout population estimates for 1993 and 1994 at Hemlock Bar were 98 and 135, respectively (Paragamian 1995a, 1995b). This may indicate that the population has increased in recent years though densities are still low. The low preferred stock density of rainbow trout observed in the Hemlock Bar reach of the Kootenai River and a lack of fish older than four years suggests a high annual mortality rate for larger rainbow trout. This observation is also supported by the high annual exploitation rate.

## **Kootenai River Juvenile Salmonid Shoreline Abundance Index**

Electrofishing results indicate age-0 rainbow trout abundance was low throughout the study reach at 72 age-0 rainbow trout/km (1,872 age-0 fish for rkm 250-275). However, Paragamian (1995a, 1995b) found no age-0 rainbow trout during shoreline electrofishing. Using a hypothetical 10% survival rate from age-0 to age-1 (Downs 2000), the mainstem could produce 187 age-1 rainbow trout (7.2/km) from the 1999 year class. In comparison, Downs (2000) estimated the mainstem would produce 100 age-1 rainbow trout (3.8/km) from the 1998 year class. Both of these densities are low for fluvial rainbow trout populations in Idaho (Schill 1991). However, the Kootenai River shoreline area is difficult to sample for age-0 salmonids, thus these densities may be highly underestimated.

## **Recruitment Overview**

Substantial rainbow trout recruitment to the braided and canyon sections of river from tributaries downstream of Bonners Ferry is unlikely. Downs (2000) found no evidence of either juveniles or adults moving upstream from the Deep Creek drainage, the major recruitment area downstream of Bonners Ferry. There is little potential for recruitment from tributaries in the braided and canyon sections either. Juvenile densities in these tributaries are low, and available spawning and rearing habitat is minimal (Partridge 1983; Paragamian 1995a). Finally, the estimated density of age-2 and older rainbow trout in the Hemlock Bar section of the Kootenai River was 64 fish/km in September 1999, while estimated age-1 densities for the study reach were only 3.8 and 7.2 fish/km for 1998 and 1999, respectively. Therefore, we believe the population upstream of Bonners Ferry is at least partly dependent on recruitment from Montana waters.

Likewise, potential bull trout recruitment from Idaho tributaries is also minimal as evidenced by screw trap and weir catches, snorkel, electrofishing, and redd surveys (Partridge 1983; Paragamian 1995a; Fredericks and Hendricks 1997; Downs 1999, 2000; this study). Although bull trout densities in the Kootenai River, Idaho are low, we believe the population is almost entirely dependent on recruitment from Montana waters. Our radio telemetry of bull trout migrating to Montana during the spawning season supports this hypothesis.

Numbers of rainbow and bull trout juveniles out-migrating from tributaries upstream of Bonners Ferry in Idaho have not been determined. Quantifying this out-migration will help

determine the proportion of rainbow and bull trout recruits coming from Idaho vs. Montana waters.

### **RECOMMENDATIONS FOR 2000**

1. Trap out-migrating juvenile rainbow and bull trout in Boulder Creek to quantify potential recruitment to the Kootenai River. Boulder Creek has the most suitable spawning habitat for Kootenai River tributaries upstream of Bonners Ferry.
2. Radio tag 20 adult rainbow and up to 20 bull trout inhabiting the Kootenai River upstream of Bonners Ferry. This will increase our sample size for identifying spawning areas.
3. Monitor radio-tagged rainbow trout during the spawning season and immediately after spawning to determine spawning tributaries and post-spawn locations. Monitor radio-tagged bull trout at least once every two weeks during the spawning season to determine spawning locations. Monitor bull trout at least once every month to determine habitat use (especially in winter) and extent of movements.
4. Reward tag adult rainbow trout in the Kootenai River upstream of Bonners Ferry to estimate angler exploitation. Exploitation should continue to be monitored to determine if 1999 was a representative year in terms of angler exploitation.
5. Repeat rainbow trout and mountain whitefish population estimates in the Hemlock Bar reach of the Kootenai River as part of long term monitoring.
6. Conduct a creel survey to establish baseline data on angling pressure and harvest before nutrient enhancement of the Kootenai River, Idaho proposed for 2003. This information will help us determine the possible benefits to anglers from nutrient enhancement efforts.
7. Provide baseline information on the trophic structure of the fish community. This information will help us monitor potential changes in the fish community due to nutrient enhancement and help identify benefits to sportfish (e.g., rainbow and cutthroat trout, mountain whitefish).

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## **APPENDICES**

Appendix A. Telemetry locations (rkm = river kilometer) for radio-tagged rainbow (Rbt) and bull (Bullt) trout, Kootenai River drainage, 1998-1999. The first location listed for each fish is the release location.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
Rbt	30.522	A	9/15/98	262.5	
			9/21/98	261.9	
			9/28/98	265.5	
			10/5/98	266.8	
			10/13/98	266.8	
			10/19/98	266.8	
			10/28/98	266.9	
			11/4/98	265.3	
			11/9/98	262.0	
			11/16/98	262.0	
			3/15/99	262.0	
			3/22/99	262.0	
			3/30/99	262.0	
			4/5/99	264.8	
			4/12/99	267.5	
			4/20/99	283.7	
			4/22/99	295.0	
			4/26/99	275.4	
			4/29/99	262.5	
			5/3/99	258.5	
			5/6/99	255.9	
			5/11/99	253.0	
			5/13/99	253.0	
			5/17/99	252.5	
			5/20/99	252.5	
			5/24/99	252.5	
			5/27/99	252.5	
			6/1/99	252.5	
			6/7/99	252.5	
			6/14/99	252.5	
			6/21/99	252.5	
			7/12/99	252.5	
			7/19/99	252.5	
			8/12/99	252.5	
			8/16/99	252.5	
			8/23/99	252.5	
			8/31/99	252.5	
			9/7/99	252.5	
			9/14/99	252.5	
			9/17/99	252.5	
			9/21/99	252.5	
			9/28/99	252.5	
Rbt	30.682	A	9/15/98	262.5	
			9/21/98	262.0	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			9/28/98	262.0	
			10/5/98	262.3	
			10/13/98	262.5	
			10/19/98	262.5	
			10/28/98	262.2	
			11/4/98	262.2	
			11/9/98	262.2	
			11/16/98	262.2	
			8/31/99	262.2	No locations between 11/17 and 8/30
Rbt	30.120	A	9/17/98	262.5	
			9/21/98	262.3	
			9/28/98	262.3	
			10/5/98	262.3	
			10/13/98	262.5	
			10/19/98	262.6	
			10/28/98	262.5	
			11/4/98	262.5	
			11/9/98	262.5	
			11/16/98	262.1	
			3/15/99	262.0	
			3/22/99	262.0	
			3/30/99	262.0	
			4/5/99	262.0	
			4/12/99	262.0	
			4/20/99	262.0	
			4/22/99	262.0	
			4/26/99	262.0	
			4/29/99	262.1	
			5/3/99	262.5	
			5/6/99	262.5	
			5/11/99	262.5	
			5/13/99	262.5	
			5/17/99	262.5	
			5/20/99	262.5	
			5/24/99	263.1	
			6/7/99	262.5	
			6/14/99	262.5	
			6/21/99	262.5	
			7/12/99	262.0	
			7/19/99	261.5	
			8/12/99	261.5	
			8/16/99	261.5	
			8/23/99	261.5	
			8/31/99	261.5	
			9/7/99	261.5	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			9/14/99	261.5	
			9/17/99	261.5	
			9/21/99	261.5	
			9/28/99	261.5	
Rbt	30.140	A	9/21/98	270.0	
			9/28/98	269.3	
			10/5/98	269.4	
			10/13/98	269.0	
			10/19/98	269.5	
			10/28/98	269.4	
			11/4/98	269.4	
			11/9/98	269.4	
			11/16/98	269.4	
			3/22/99	269.5	
			3/30/99	269.5	
			4/5/99	269.5	
			4/12/99	272.2	
			4/20/99	272.0	
			4/22/99	270.6	
			4/26/99	269.7	
			4/29/99	269.7	
			5/3/99	269.1	
			5/6/99	269.5	
			5/11/99	270.6	up Caboose Creek
			5/13/99	270.5	
			5/17/99	271.0	
			5/20/99	271.0	
			5/24/99	271.0	
			5/27/99	270.6	
			6/1/99	270.6	
			6/7/99	270.6	
			6/14/99	270.6	
			6/21/99	270.2	
			7/12/99	270.2	
			7/19/99	270.2	
			8/12/99	270.2	
			8/16/99	270.2	
			8/23/99	270.2	
			8/31/99	270.2	
			9/7/99	270.2	
			9/14/99	270.2	
			9/17/99	270.2	
			9/21/99	270.2	
			9/28/99	270.2	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
Rbt	30.541	A	9/21/98	271.5	
			9/28/98	275.4	
			10/5/98	274.1	
			10/13/98	273.5	
			10/19/98	272.5	
			10/28/98	272.5	
			11/9/98	273.0	
			11/16/98	273.0	
			3/22/99	272.5	
			3/30/99	272.5	
			4/5/99	272.5	
			4/12/99	272.7	
			4/20/99	272.7	
			4/22/99	272.7	
			4/26/99	272.7	
			4/29/99	272.7	
			5/3/99	272.7	
			5/6/99	272.7	
			5/11/99	272.7	
			5/13/99	272.7	
			5/14/99	272.7	location by boat
			5/17/99	272.7	
			5/20/99	272.7	
			5/24/99	272.7	
			6/14/99	272.7	
			6/21/99	272.9	
			7/12/99	273.0	
			7/19/99	273.0	
			8/16/99	273.0	
			8/23/99	273.0	
			8/31/99	273.0	
			9/7/99	273.0	
			9/14/99	273.0	
			9/17/99	273.0	
			9/21/99	273.0	
			9/28/99	273.0	
Rbt	30.641	A	9/21/98	270.0	
			9/28/98	269.0	
			10/5/98	269.3	
			10/13/98	268.5	
			10/19/98	268.0	
			10/27/98	268.0	
			11/4/98	267.9	
			11/9/98	267.8	
			11/23/98	267.8	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			3/22/99	268.5	
			3/30/99	272.3	
			4/5/99	272.3	
			4/12/99	275.0	
			4/20/99	275.0	
			4/22/99	275.0	
			4/26/99	275.0	
			4/29/99	275.4	
			5/3/99	275.4	
			5/6/99	275.4	
			5/11/99	275.4	up Boulder Creek
			5/13/99	275.4	up Boulder Creek
			5/14/99	275.4	up Boulder Creek; location from ground
			5/17/99	275.4	up Boulder Creek
			5/20/99	275.4	up Boulder Creek
			5/24/99	275.4	up Boulder Creek
			5/27/99	271.8	
			6/1/99	270.6	
			6/7/99	270.6	
			6/14/99	270.6	
			6/21/99	270.6	
			7/12/99	270.6	
Rbt	30.742	A	9/21/98	271.5	
			9/28/98	274.1	
			10/5/98	274.0	
			10/13/98	273.9	
			10/19/98	274.0	
			10/27/98	274.0	
			11/4/98	274.0	
			11/9/98	274.0	
			11/16/98	274.0	
			3/22/99	273.5	
			3/30/99	274.1	
			4/5/99	274.2	
			4/12/99	274.5	
			4/20/99	300.3	
			4/22/99	300.3	
			4/29/99	300.3	
			5/3/99	300.3	
			5/6/99	300.3	up Lake Creek
			5/11/99	300.3	up Lake Creek
			5/13/99	300.3	up Lake Creek
			5/17/99	300.3	up Lake Creek
			5/20/99	300.3	up Lake Creek
			5/24/99	300.3	up Lake Creek

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			5/27/99	300.3	up Lake Creek
			6/1/99	274.0	
			6/7/99	274.0	
			6/14/99	274.2	
			6/21/99	273.8	
Rbt	30.792	A	9/21/98	271.5	
			9/28/98	273.5	
			10/5/98	254.5	
			10/13/98	256.5	
			10/19/98	255.5	
			10/28/98	255.5	
			11/4/98	255.5	
			11/9/98	255.7	
			11/16/98	255.7	
			3/22/99	255.1	
			3/30/99	255.1	
			4/5/99	255.1	
			4/12/99	255.1	
			4/19/99	255.1	
			4/22/99	255.1	
			4/26/99	255.1	
			4/29/99	255.1	
			5/3/99	255.1	
			5/6/99	255.1	
			5/11/99	255.1	
			5/13/99	255.1	
			5/17/99	255.1	
			5/20/99	255.1	
			5/24/99	255.1	
			6/7/99	255.1	
			6/14/99	255.1	
			6/21/99	255.1	
			7/12/99	255.1	
			7/19/99	255.1	
			8/12/99	255.1	
			8/16/99	255.1	
			8/23/99	255.1	
			8/31/99	255.1	
			9/7/99	255.1	
			9/14/99	255.1	
			9/17/99	255.1	
			9/21/99	255.1	
			9/28/99	255.1	
Rbt	30.573	B	9/22/98	263.0	

## Appendix A. Continued.

<b>Species</b>	<b>Radio Frequency</b>	<b>Transmitter Type<sup>a</sup></b>	<b>Date</b>	<b>Location (rkm)</b>	<b>Notes</b>
			9/28/98	263.8	
			10/5/98	263.9	
			10/13/98	263.5	
			10/19/98	264.0	
			10/27/98	263.9	
			11/4/98	263.9	
			11/9/98	263.9	
			11/16/98	263.9	
			12/22/98	263.6	
			1/4/99	263.5	
			1/19/99	263.5	
			2/3/99	263.8	
			2/18/99	263.8	
			3/1/99	264.0	
			3/15/99	264.0	
			3/22/99	264.0	
			3/30/99	264.0	
			4/5/99	264.0	
			4/12/99	264.0	
			4/19/99	264.0	
			4/22/99	264.0	
			4/26/99	264.0	
			4/29/99	264.0	
			5/3/99	263.9	
			5/6/99	263.5	
			5/11/99	263.5	
			5/13/99	263.5	
			5/17/99	263.5	
			5/20/99	263.5	
			5/24/99	263.5	
			5/27/99	263.5	
			6/1/99	263.5	
			6/7/99	263.5	
			6/14/99	263.5	
			6/21/99	263.5	
			7/12/99	263.5	
			7/19/99	263.5	
			8/12/99	263.5	
			8/16/99	263.5	
			8/23/99	263.5	
			8/31/99	263.5	
			9/7/99	263.5	
			9/14/99	263.5	
			9/17/99	263.5	
			9/21/99	263.5	
			9/28/99	263.5	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
Rbt	30.583	B	9/22/98	268.0	
			9/28/98	266.8	
			10/5/98	266.8	
			10/13/98	266.0	
			10/19/98	266.8	
			10/27/98	267.5	
			11/4/98	272.1	
			11/9/98	272.6	
			11/23/98	271.6	
			12/22/98	267.1	
			1/4/99	267.1	
			1/19/99	267.1	
			2/3/99	267.1	
			2/18/99	267.6	
			3/1/99	267.6	
			3/15/99	268.5	
Rbt	30.633	B	9/22/98	266.0	
			9/28/98	266.8	
			10/5/98	266.3	
			10/13/98	266.2	
			10/19/98	266.8	
			10/27/98	266.0	
			11/4/98	266.0	
			11/9/98	266.9	
			11/23/98	266.9	not searched for from 11/24/98-2/2/99
			2/3/99	265.6	
			2/18/99	265.6	
			3/1/99	265.6	
			3/15/99	266.3	
			3/22/99	266.0	
			3/30/99	266.0	
			4/5/99	266.0	
			4/12/99	265.9	
			4/20/99	266.1	
			4/22/99	272.0	
			4/26/99	291.2	
			4/29/99	298.5	
			5/3/99	299.5	
			5/6/99	299.5	up Callahan Creek
			5/11/99	299.5	up Callahan Creek
			5/13/99	299.5	up Callahan Creek
			5/17/99	299.5	up Callahan Creek
			5/20/99	299.5	up Callahan Creek
			5/24/99	299.5	up Callahan Creek
			5/27/99	299.5	up Callahan Creek

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			6/1/99	299.5	up Callahan Creek
			6/7/99	299.5	up Callahan Creek
			6/14/99	299.5	up Callahan Creek
			6/21/99	299.5	up Callahan Creek
			7/12/99	265.5	
			7/19/99	265.5	
			8/12/99	265.5	
			8/16/99	265.5	
			8/23/99	265.5	
			8/31/99	265.5	
			9/7/99	265.5	
			9/14/99	265.5	
			9/17/99	265.5	
			9/21/99	265.5	
			9/28/99	265.5	
Rbt	30.772	A	9/22/98	266.0	
			9/28/98	266.6	
			10/5/98	265.6	
			10/13/98	265.6	
			10/19/98	275.6	
			4/1/99	300.3	
			4/5/99	300.3	
			4/8/99	300.3	
			4/12/99	300.3	
			4/19/99	300.3	
			4/20/99	300.3	
			4/22/99	300.3	
			4/26/99	300.3	
			4/29/99	300.3	
			5/3/99	300.3	
			5/6/99	300.3	
			5/4/99	300.3	location from ground
			5/7/99	300.3	location from ground
			5/11/99	300.3	
			5/13/99	300.3	
			5/17/99	300.3	up Lake Creek
			5/20/99	300.3	up Lake Creek
			5/24/99	300.3	up Lake Creek
			5/27/99	300.3	up Lake Creek
			6/1/99	300.3	up Lake Creek
			6/7/99	300.3	up Lake Creek
			6/14/99	300.3	
			6/21/99	300.5	
			7/12/99	300.5	
			7/19/99	300.5	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			8/12/99	300.5	
			8/16/99	300.5	
			8/23/99	300.5	
			8/31/99	300.5	
			9/7/99	300.5	
			9/14/99	300.5	
			9/17/99	300.5	
			9/21/99	300.5	
			9/28/99	300.5	
Rbt	30.552	A	9/24/98	254.0	
			10/6/98	254.4	
			10/13/98	253.6	
			10/19/98	255.6	
			10/27/98	255.6	
			11/4/98	255.7	
			11/9/98	255.8	
			11/16/98	255.8	
Rbt	30.722	A	9/24/98	257.5	
			10/5/98	257.8	
			10/13/98	257.8	
			10/19/98	258.5	
			11/23/98	258.4	
			3/22/99	258.4	
			3/30/99	258.5	
			4/5/99	258.5	
			4/12/99	258.5	
			4/20/99	258.5	
			4/22/99	258.5	
			4/26/99	258.5	
			4/29/99	258.5	
			5/3/99	258.5	
			5/6/99	258.5	
			5/11/99	258.5	
			5/13/99	258.5	
			5/17/99	258.5	
			5/20/99	258.5	
			5/24/99	258.5	
			5/27/99	258.5	
			6/1/99	258.5	
			6/7/99	258.2	
			6/14/99	258.2	
			6/21/99	258.6	
			7/12/99	258.6	
			7/19/99	258.6	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
Rbt	30.180	A	8/12/99	258.6	
			8/16/99	258.6	
			8/23/99	258.6	
			8/31/99	258.6	
			9/7/99	258.6	
			9/14/99	258.6	
			9/17/99	258.6	
			9/21/99	258.6	
			9/28/99	258.6	
			10/1/98	275.5	
			10/5/98	275.0	
			10/13/98	275.0	
			10/19/98	275.0	
			10/27/98	275.0	
			11/4/98	275.0	
			11/9/98	275.2	
			11/16/98	275.2	
			4/1/99	300.3	
			4/5/99	307.6	
			4/8/99	308.5	
			4/12/99	308.5	
			4/19/99	309.0	
			4/20/99	309.0	
			4/22/99	308.5	
			4/26/99	308.0	
			4/29/99	306.5	
			5/3/99	308.5	
			5/11/99	308.5	
			5/13/99	306.3	
			5/17/99	304.0	
			5/20/99	308.5	
			5/24/99	308.5	
			5/27/99	303.7	
			6/1/99	301.5	
			6/7/99	304.0	
			6/14/99	304.0	
			6/21/99	275.6	
			7/12/99	275.6	
			7/19/99	275.6	
			8/12/99	275.6	
			8/16/99	275.6	
			8/23/99	275.6	
			8/31/99	275.6	
			9/7/99	275.6	
			9/14/99	275.6	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			9/17/99	275.6	
			9/21/99	275.6	
			9/28/99	275.6	
Rbt	30.562	A	10/1/98	272.5	
			10/5/98	275.5	
			10/13/98	273.8	
			10/19/98	272.4	
			10/27/98	274.0	
			4/8/99	274.0	
Rbt	30.612	A	10/1/98	272.5	
			10/5/98	273.0	
			10/13/98	273.3	
			10/19/98	272.3	
			10/27/98	272.3	
			11/4/98	272.2	
			11/9/98	272.3	
			11/23/98	272.3	
			3/30/99	277.4	
			4/5/99	272.6	
			4/12/99	272.6	
			4/19/99	272.0	
			4/22/99	273.0	
			4/26/99	272.5	
			4/29/99	272.3	
			5/3/99	272.3	
			5/6/99	272.3	
			5/11/99	272.3	
			5/13/99	272.3	
			5/14/99	272.3	location by boat
			5/17/99	272.3	
			5/20/99	272.3	
			5/24/99	272.3	
			5/27/99	272.3	
			6/1/99	272.3	
			6/7/99	272.3	
			6/14/99	272.3	
			6/21/99	272.4	
			7/12/99	272.0	
			7/19/99	272.0	
			8/12/99	272.0	
			8/16/99	272.0	
			8/23/99	272.0	
			8/31/99	272.0	
			9/7/99	272.0	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			9/14/99	272.0	
			9/17/99	272.0	
			9/21/99	272.0	
			9/28/99	272.0	
Rbt	30.701	A	10/1/98	275.5	
			10/5/98	275.7	
			10/13/98	275.7	
			10/19/98	275.8	
			10/27/98	275.8	
			11/4/98	275.8	
			11/9/98	275.8	
			11/16/98	275.8	
			3/30/99	275.8	
			4/5/99	275.8	
			4/12/99	275.8	
			4/19/99	275.8	
			4/22/99	275.8	
			4/26/99	275.8	
			4/29/99	275.8	
			5/3/99	275.8	
			5/6/99	275.8	
			5/11/99	275.8	
			5/13/99	275.8	
			5/14/99	275.8	location by boat
			5/17/99	275.8	
			5/20/99	275.8	
			5/24/99	275.8	
			5/27/99	275.6	
			6/1/99	275.6	
			6/7/99	275.8	
			6/14/99	275.8	
			6/21/99	275.8	
			7/12/99	275.8	
			7/19/99	275.8	
			8/12/99	275.8	
			8/16/99	275.8	
			8/23/99	275.8	
			8/31/99	275.8	
			9/7/99	275.8	
			9/14/99	275.8	
			9/17/99	275.8	
			9/21/99	275.8	
			9/28/99	275.8	
Rbt	30.762	A	10/1/98	272.5	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			10/5/98	271.6	
			10/13/98	272.2	
			10/19/98	272.0	
			10/27/98	272.2	
			11/4/98	272.2	
			11/9/98	271.6	
			11/16/98	271.6	
			3/30/99	271.5	
			4/5/99	271.8	
			4/12/99	271.8	
			4/19/99	272.0	
			4/22/99	272.0	
			4/26/99	272.0	
			4/29/99	272.3	
			5/3/99	272.3	
			5/6/99	272.3	
			5/11/99	272.3	
			5/13/99	272.3	
			5/14/99	272.3	location by boat
			5/17/99	272.3	
			5/20/99	272.3	
			5/24/99	272.3	
			5/27/99	272.3	
			6/1/99	272.3	
			6/7/99	272.3	
			6/14/99	272.3	
			6/21/99	273.0	
			8/12/99	272.0	
			8/16/99	272.0	
			8/23/99	272.0	
			8/31/99	272.0	
			9/7/99	272.0	
			9/14/99	272.0	
			9/17/99	272.0	
			9/21/99	272.0	
			9/28/99	272.0	
Rbt	30.592	A	3/10/99	274.5	
			3/15/99	274.5	
			3/22/99	274.5	
			3/30/99	274.5	
			4/5/99	274.5	
			4/12/99	274.5	
			4/19/99	274.5	
			4/22/99	274.5	
			4/26/99	274.5	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			4/29/99	274.5	
			5/3/99	274.4	
			5/6/99	274.4	
			5/11/99	291.3	
			5/17/99	308.5	
			5/20/99	309.0	
			5/24/99	309.0	
			5/27/99	310.0	
			6/1/99	310.0	
			6/7/99	309.5	
			6/14/99	281.5	
			6/21/99	273.8	
Rbt	30.312	A	3/30/99	264.0	
			4/5/99	257.4	
			4/12/99	253.5	
Rbt	30.503	B	3/30/99	264.0	
			4/5/99	259.5	
			4/12/99	280.9	
			4/19/99	273.0	
			4/22/99	275.4	up Boulder Creek
			4/26/99	275.4	up Boulder Creek
			4/29/99	275.4	up Boulder Creek
			5/3/99	275.4	up Boulder Creek
			5/6/99	275.4	up Boulder Creek
			5/17/99	264.8	
			5/20/99	265.5	
			5/24/99	254.5	
			5/27/99	254.5	
			6/1/99	254.0	
			6/7/99	253.7	
			6/14/99	254.0	
			6/21/99	254.0	
			7/12/99	254.0	
Rbt	30.602	A	3/30/99	264.0	
			4/5/99	264.0	
Bullt	30.452	C	9/10/98	262.5	
			9/14/98	259.5	
			9/21/98	259.6	
			9/28/98	266.5	
			10/5/98	265.5	
			10/8/98	266.0	
			10/13/98	266.0	

Appendix A. Continued.

<b>Species</b>	<b>Radio Frequency</b>	<b>Transmitter Type<sup>a</sup></b>	<b>Date</b>	<b>Location (rkm)</b>	<b>Notes</b>
			10/15/98	265.5	
			10/19/98	266.5	
			10/28/98	266.0	
			11/4/98	265.6	
			11/9/98	265.6	
			11/23/98	265.7	
			12/7/98	265.7	
			12/14/98	265.5	
			12/22/98	265.5	
			1/4/99	266.5	
			1/19/99	266.6	
			2/3/99	266.6	
			2/18/99	266.6	
			3/1/99	266.7	
			3/15/99	267.0	
			3/22/99	267.0	
			3/30/99	267.0	
			4/5/99	267.0	
			4/12/99	267.0	
			4/20/99	267.0	
			4/22/99	267.0	
			4/26/99	267.0	
			4/29/99	267.0	
			5/3/99	267.0	
			5/6/99	267.0	
			5/11/99	267.0	
			5/13/99	267.0	
			5/17/99	267.0	
			5/20/99	267.0	
			5/24/99	267.0	
			5/27/99	267.0	
			6/1/99	267.0	
			6/7/99	267.0	
			6/11/99	267.0	
			6/14/99	266.8	
			6/17/99	267.0	
			6/21/99	285.0	
			6/24/99	285.5	
			7/19/99	301.2	16.1 km up O'Brien Creek
			7/22/99	301.2	16.1 km up O'Brien Creek
			7/28/99	301.2	4.2 km up O'Brien Creek
			8/2/99	301.2	2.6 km up O'Brien Creek
			8/5/99	301.2	2.6 km up O'Brien Creek
			8/9/99	301.2	3.2 km up O'Brien Creek
			8/12/99	301.2	2.6 km up O'Brien Creek
			8/16/99	301.2	3.2 km up O'Brien Creek

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			8/23/99	301.2	3.2 km up O'Brien Creek
			8/31/99	301.2	
			9/7/99	301.2	
			9/14/99	301.2	
			9/17/99	301.2	
			9/21/99	301.2	
			9/28/99	301.2	
			10/5/99	301.2	
			10/14/99	301.1	
			10/19/99	282.5	
			10/26/99	268.5	
			11/1/99	265.0	
			11/9/99	267.0	
			11/29/99	267.0	
			12/14/99	267.0	
Bullt	30.623	C	9/24/98	256.0	up Myrtle Creek? 0.5 km up Myrtle Creek at mouth of Myrtle Creek
			10/13/98	212.5	
			10/15/98	239.5	
			10/19/98	239.1	
			10/27/98	235.5	
			11/4/98	234.6	
			11/9/98	234.6	
			11/23/98	234.6	
			12/14/98	234.6	
			12/22/98	234.6	
			1/4/99	239.2	
			1/19/99	236.7	
			2/3/99	240.9	
			2/18/99	242.3	
			3/1/99	242.3	
			3/15/99	236.8	
			3/22/99	237.0	
			3/30/99	236.0	
			4/5/99	236.0	
			4/12/99	241.0	
			4/20/99	240.5	
			4/22/99	240.0	
			4/26/99	249.6	
			4/29/99	256.0	
			5/3/99	256.5	
			5/6/99	256.5	
			5/11/99	258.5	
			5/13/99	258.5	
			5/17/99	258.5	
			5/24/99	258.5	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			5/27/99	258.0	
			6/1/99	258.2	
			6/7/99	258.6	
			6/11/99	258.6	
			6/14/99	258.6	
			6/17/99	258.6	
			6/21/99	258.6	up the Moyie River
			6/24/99	258.6	
			7/12/99	265.5	
			7/15/99	285.6	
			7/19/99	298.1	
			7/22/99	299.0	
			7/28/99	299.5	
			8/2/99	299.4	
			8/5/99	299.4	
			8/9/99	299.5	
			8/12/99	299.5	
			8/16/99	299.4	
			8/23/99	299.4	
			8/31/99	299.4	
			9/7/99	299.4	
			9/14/99	299.5	
			9/17/99	299.5	
			9/21/99	299.5	
			9/28/99	299.3	
			10/5/99	299.5	
			10/14/99	299.5	
			10/19/99	299.4	
			10/26/99	305.0	
			11/1/99	234.5	
			11/9/99	234.5	
			11/29/99	234.5	
			12/14/99		no location
Bullt	30.711	C	10/1/98	275.5	
			10/5/98	275.5	
			10/8/98	262.0	
			10/13/98	203.4	
			10/15/98	203.4	
			10/19/98	234.0	
			10/28/98	253.0	
			11/4/98	253.0	
			11/9/98	254.0	
			11/16/98	254.0	
			11/23/98	254.0	
			12/7/98	253.5	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			12/14/98	252.5	
			1/4/99	253.0	
			1/19/99	253.5	
			2/3/99	262.0	
			2/18/99	262.0	
			3/1/99	262.5	
			3/15/99	268.5	
			3/22/99	273.5	
			3/30/99	274.2	
			4/5/99	274.1	
			4/12/99	275.4	
			4/19/99	274.3	
			4/22/99	274.3	
			4/26/99	274.3	
			4/29/99	274.3	
			5/3/99	274.3	
			5/6/99	273.5	
			5/11/99	273.0	
			5/13/99	272.3	
			5/17/99	272.3	
			5/20/99	270.6	
			5/24/99	270.6	
			5/27/99	270.7	
			6/1/99	270.7	
			6/7/99	272.7	
			6/11/99	272.7	
			6/14/99	275.0	
			6/17/99	275.1	
			6/21/99	273.5	
			6/24/99	275.6	
			7/12/99	305.1	
			7/15/99	306.5	
			7/19/99	306.8	
			7/22/99	308.2	
			7/28/99	308.2	
			8/2/99	301.2	
			8/5/99	301.2	
			8/9/99	301.1	
			8/12/99	301.2	
			8/16/99	289.4	
			8/23/99	275.5	
			8/31/99	275.6	
			9/7/99	275.7	
			9/14/99	275.7	
			9/17/99	275.5	
			9/21/99	275.5	

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			9/28/99	275.5	
			10/5/99	275.5	
			10/14/99	275.5	
			10/19/99	275.5	
			10/26/99	275.5	
			11/1/99	275.5	
			11/9/99	275.5	
			11/29/99	275.5	
			12/14/99	275.5	
Bullt	30.241	D	9/15/99	262.5	
			9/17/99	264.1	
			9/21/99	262.0	
			9/28/99	262.0	
			10/5/99	262.0	
			10/14/99	262.0	
			10/19/99	262.0	
			10/26/99	262.0	
			11/1/99	262.0	
			11/9/99	262.5	
			11/29/99	262.5	
			12/14/99	262.0	
Bullt	30.654	E	10/1/99	301.2	O'Brien Creek
			10/5/99	293.1	
			10/14/99	217.5	
			10/19/99	216.5	
			10/26/99	216.5	
			11/1/99	216.5	
			11/9/99	216.5	
			11/29/99	216.0	
			12/14/99	216.0	
Bullt	30.474	E	10/1/99	301.2	O'Brien Creek
			10/5/99	300.2	
			10/14/99	275.1	
			10/19/99	258.4	
			10/26/99		no location
			11/1/99		no location
			11/9/99	258.6	up Moyie River about 0.2 km
			11/29/99	258.6	up Moyie River about 0.2 km
			12/14/99	259.0	
Bullt	31.423	E	10/8/99	301.2	O'Brien Creek
			10/14/99		no location
			10/19/99		no location

## Appendix A. Continued.

Species	Radio Frequency	Transmitter Type <sup>a</sup>	Date	Location (rkm)	Notes
			10/26/99	207.5	
			11/1/99	207.5	
			11/9/99	207.5	
			11/29/99	120.0	
			12/14/99		no location
Bullt	30.191	D	10/8/99	301.2	O'Brien Creek
			10/14/99	304.8	
			10/19/99	305.1	
			10/26/99	305.1	
			11/1/99	305.8	
			11/9/99	305.8	
			11/29/99	304.5	
			12/14/99	304.5	
Bullt	30.333	E	10/8/99	301.2	O'Brien Creek
			10/14/99	301.3	
			10/19/99	302.0	
			10/26/99	300.3	
			11/1/99	306.0	
			11/9/99		no location
			11/29/99	304.7	
			12/14/99	304.7	
Bullt	30.031	D	10/8/99	301.2	O'Brien Creek
			10/14/99	300.9	
			10/19/99	300.5	
			10/26/99	205.7	
			11/1/99	173.0	
			11/9/99	173.0	
			11/29/99	173.0	
			12/14/99	173.0	
Bullt	30.251	D	10/8/99	301.2	O'Brien Creek
			10/14/99	222.0	
			10/19/99	226.0	
			10/26/99	226.3	
			11/1/99	226.3	
			11/9/99	226.3	
			11/29/99	226.3	
			12/14/99	226.3	
Bullt	30.394	E	10/8/99	301.2	O'Brien Creek
			10/14/99	301.2	
			10/19/99	300.5	
			10/26/99	299.5	

Appendix A. Continued.

<b>Species</b>	<b>Radio Frequency</b>	<b>Transmitter Type<sup>a</sup></b>	<b>Date</b>	<b>Location (rkm)</b>	<b>Notes</b>
			11/1/99	299.5	
			11/9/99	299.5	
			11/29/99	299.5	
			12/14/99	299.5	

<sup>a</sup> A = tag wt 7.35-8.2 g, 90 on/90 off/160 on duty cycle, life of 250 d; B = tag wt 7.9-8.2 g, life of 200 d; C = tag wt 10-11 g, life of 360 d; D = tag wt 18.36-18.81 g, life of 730 d; E = tag wt 25.1-25.31 g, life of 912 d.

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